BALL GRID ARRAY PACKAGE WITH HEAT SINK DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to provide heat sink device for heat dissipation in an integrated circuit, and more particularly to a ball grid package array with heat sink device to reduce the thermal resistance and to improve the thermal dissipation.

2. Description of the Prior Art

In the electronics and computer industries, it has been well known to employ various types of electronic device packages and integrated circuit chips, such as the PENTIUM central processing unit chip (CPU) manufactured by Intel Corporation and RAM (random access memory) chips. These integrated circuit chips have a pin grid array (PGA) package and are typically installed into a socket, which is soldered to a computer circuit board. These integrated circuit device, particularly the CPU microprocessor chips, generate a great deal off heat during operation which must be removed to prevent adverse effects on operation of the PENTIUM microprocessor, containing millions of transistors, is highly susceptible to overheating which could

destroy the microprocessor device itself or other components proximal to the microprocessor.

In addition to the microprocessors discussed above, there are many other types of semiconductor device packages, which are commonly used in computer equipment. For example, resistors and thermistors generate large volumes of heat during normal operation and are also subject to failure if not cooled properly.

Also, the solid-state devices are commonly being installed onto a circuit board, which is, in turn, installed into a motherboard, or other similar primary circuit board. For example, microprocessors, such as the PENTIUM II and the Celeron from Intel, are "processor cards" which are installed into a motherboard of a computer in similar fashion to the way a modem is installed into a motherboard. On a given processor card is typically the processor semiconductor devices that are necessary for the operation of the card, such cache chips, or the like. The processor package may be installed into the processor card via a pin grid, ball grid, and land grid array and with a socket such as a ZIF or ball grid socket.

In similar, fashion to the earlier semiconductor devices discussed above, many different types of electronic devices suffers from overheating. For example, any electronic device package may have a

threat of overheating. However, there are many types of electronic device that need cooling; however, the devices are too small to adequately support and receive the typical metallic heat sink. These prior metallic heat sinks are commonly glued directly to the electronic device with a thermally conductive adhesive, or plant to the electronic device package with a mechanical structure, such as a spring clip. Further, gap pads are often required to even out the interface surface to achieve satisfactory thermal conductivity. In view of the foregoing issues related to these types of electronic components, providing heat dissipation in the form of heat sinks, and the like, are difficult and cost prohibitive.

The foregoing heat sink assembly of the prior art suffers from the disadvantages of having multiple components and the high cost associated therewith. These multiple component heat sink assemblies typically include expensive machined or extruded heat conductive metal, such as aluminum. Other parts, such as springs or addition clips require separate machining steps and/or molds for production. Therefore, these assemblies and methods are completely inappropriate for most electronic devices.

Referring to FIG. 1 and FIG. 2, show the conventional ball grid array package 100 with heat slug. The ball grid array package with heat slug includes a ball grid array substrate 102, a chip, or die 104 on

the ball grid array substrate 102, and a modified heat slug 106 over the chip 104 and the ball grid array substrate 102. Then, a molding compound 108 is injected into the ball grid array package to accomplish the ball grid array package manufacturing. Regard to FIG. 2, the die or chip 104 is covered below the molding compound 108, the thermal conductivity of the molding compound 108 is too low to cause the heat dissipating effect is limited by the heat dissipating path. The solution method is to add an embedded heat slug 108 onto the die or chip 104 to increase the heat dissipating area. Nevertheless, the defect of this technique is that the large volume of heat, which is generated by the die or chip 104 that cannot be removed to the environment to reduce the operating temperature of the die or chip 104, so as to cause the chip or die 104 cannot operate.

SUMMARY OF THE INVENTION

It is an object of this invention is to provide heat sink body with heat dissipating members thereon, wherein the heat sink body is formed by casting to increase the heat dissipation effect.

It is another object of this invention is to provide a conductive protruding block on the backside of the heat sink body to associate the cavity of the ball grid array package of modified embedded heat slug to improve the heat conductivity.

It is a further object of this invention is to provide at least two conductive pillars on the backsides of heat sink body to join the opening of the bottom plate.

It is yet object of this invention is to provide a bottom plate to join the first part of the heat sink assemblies with the at least two conductive pillar to contact with the backside of the PC board to introduce the heat which is generated by the die or chip that from the backside of the PC board through the bottom plate to the at least conductive pillar of the first heat sink assemblies to the heat dissipating members thereon to remove the heat.

According to abovementioned objects, the present invention provides the heat sink device for the modified embedded heat slug with ball grid array package to improve the heat dissipation. The heat sink device is constructed of first part of heat sink assembly and the second part of heat sink assembly. The first part of heat sink assembly comprises a heat dissipating element above the heat sink body, and at least two conductive pillars below the two sides of the heat sink body, which is used to increase the heat dissipating area; a conductive protruding block below the backside of the heat sink body, wherein the conductive protruding block used to associate with the cavity of the ball grid array package of modified embedded heat slug to increase the

heat conductivity. In addition, the second part of the heat sink assembly is a bottom plate, which includes the protruding part in the central of the bottom plate, and at least two opening on the sides of the bottom plate respectively, wherein the protruding part is used to contact with the backside of the PC board, so as to increase the heat dissipation to remove the heat that is generated die or chip, and to join the at least two conductive pillars of the heat sink body to fix first part of heat sink assembly, second part of heat sink assembly, and the ball grid array package on the PC board that between the first part and second part of assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic representation the lateral view of device of the ball grid array package with the modified embedded heat slug in accordance with the prior conventional technique;

FIG. 2 is a schematic representation the cross-section view of

device of the ball grid array package with modified embedded heat slug in accordance with the prior conventional technique;

FIG. 3 is a schematic representation the cross-sectional view of the structure of a first part of heat sink assembly includes a heat sink body, a heat-dissipating element thereon, at least two conductive pillars below the two sides of the heat sink body, and a conductive protruding block below the backside of the heat sink body in accordance with the device disclosed herein;

FIG.4 is a schematic representation the cross-sectional view of the thermal conductive adhesive tape spread overall the surface of backside of the heat sink body to fix and to increase the heat dissipation in accordance with the device disclosed herein;

FIG.5 is a schematic representation the cross-sectional view of the structure of the ball grid array package with modified embedded heat slug on the PC board in accordance with the device disclosed herein;

FIG.5 is a schematic representation the cross-sectional view of the thermal conductive adhesive tape spread overall the surface of backside of the heat sink body to increase the heat dissipation in accordance with the device disclosed herein;

FIG. 6 is a schematic representation the cross-sectional view of the structure of the second part of heat sink assembly in accordance with the device disclosed herein;

FIG. 7 is a schematic representation the cross-sectional view of the conductive pillars of the heat sink body passed through the at least two holes of the PC board to fix the PC board in accordance with the device disclosed herein; and

FIG. 8 is a schematic representation the heat transfer is introduced from the PC board to the heat sink assembly in accordance with the structure disclosed herein.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Some sample embodiments of the invention will now be described in greater detail. Nevertheless, it should be recognized that the present invention can be practiced in a wide range of other embodiments besides those explicitly described, and the scope of the present invention is expressly not limited except as specified in the accompanying claims.

The present invention provides the heat sink device for the ball

grid array package with modified embedded heat slug techniques to reduce the thermal resistance and to increase the heat dissipation capability. The FIG. 3 through FIG. 7 showing the structure, function, and the relationship there-between of the heat sink device, and FIG. 8 represents the heat-dissipating path that according to the heat sink device as the present invention provided. FIG. 3 represents the structure of the first part of the heat sink assembly 1A, which comprises a first heat dissipating element as a heat sink body 2 that having a second heat dissipating element 4, such as a heat dissipating fin thereon that is used to increase the heat dissipating area to improve the heat dissipation, and at least two conductive pillars 6 on the backside of the first heat dissipating element 2 that is used to connect with the ball grid array package with modified embedded heat slug on the PC (printed circuit) board (as shown in FIG. 5), and to connect the second part of the heat sink assembly (as shown in FIG. 4).

The key feature of the present invention is that the first heat dissipating element 2 is made of conductive material such as metal, and is formed by casting, such that the heat dissipating effect would be improved. Another key feature of the present invention is that at least two conductive pillars 6 on the backside of the first heat dissipating element 2 that takes place the conventional plastic pillars on the backside of the first heat dissipating element 2 to increase the heat dissipating effect.

As referring to FIG. 3, the first heat-dissipating element 2 further comprises a conductive protruding block 8 on the backside of first heat dissipating element 2. The conductive protruding block 8 used to contact with the cavity 24 of the ball grid array package with modified embedded heat slug to increase the heat dissipation, when the integrated circuit is operated to generate a large of heat in the computer. In alternative preferred embodiment, the thermal conductive adhesive tape 10 is spread overall the surface of backside of the first heat-dissipating element 2 (as shown in FIG. 4) that is used to contact with the surface of the molding compound 26 of the BGA and to introduce the heat conductivity to increase the heat dissipation effect.

Another alternative embodiment of the present invention, as shown in FIG. 4, the thermal conductive adhesive tape 10 are on the backside of the first heat dissipating element 2, wherein the thermal conductive adhesive tape 10 is spread around the backside of the first heat dissipating element 2, but beside the conductive protruding block 8. The key feature of the present invention, the conductive protruding block 8 is made by the shaping-unity with the first heat-dissipating element 2, and located on the backside of the first heat-dissipating element 2 or added additional on the backside of the first heat-dissipating element 2 independently.

Referring to FIG. 5, which represents the structure of the ball grid array package with modified embedded heat slug on the PC board. The structure includes a ball grid array package substrate 20, a modified embedded heat slug 22 on the ball grid array package substrate 20, wherein the modified embedded heat slug 22 having a cavity 24, which is used to reduce the thickness of the molding compound 26 when molding compound is mold into the ball grid array package. In addition, the plurality of ball 28 below the ball grid array package substrate 20 to connect with the PC board 12. Furthermore, the PC board 12 have as least two holes 14 thereon to pass through the at least two conductive pillars 6.

In another embodiment, as shown in FIG. 5, for connecting with the molding compound 26 on the surface of the ball grid array package 22, and the conductive protruding block is embedded into the cavity 24 of the heat slug on the ball grid array package 22 when the PC board 12 without holes 14 therein to provide the at least two conductive pillars 6 pass through. Further, the conductive material can use as an adhesive material to add there-between to adhere the first heat dissipating element 2 and the ball grid array package 22.

Referring to FIG. 6, which represents the structure of the second part of heat sink assembly 1B. The second part of heat sink assembly

1B is a bottom plate, which has at least two openings 34 on the sides and a protruding portion 32 of the central of the bottom plate 1B, wherein at least two openings 34 used to join the at least two conductive pillars 6, and the first part of the heat sink assembly 1A is fixed with the second part of the heat sink assembly 1B by the groove 7 of the at least two conductive pillars 6 and the blot 36 of the opening 34.

Furthermore, the protruding portion of the central 32 of the bottom plate 1B can contact with the backside of the PC board 12, such that the heat can be removed from the bottom plate 1B, to the at least two conductive pillars 6, and the second heat dissipating element 4 to the outside. The advantage of the abovementioned description is that the dissipating space of backside of the PC board 12 can be increased to improve the heat dissipating effect. Moreover, the second part of heat sink assembly can use for the conventional BGA (ball grid array) package or TEBGA (thermal enhanced ball grid array) package without using conductive protruding block 8.

Referring to FIG. 7, which represents the conductive pillars 6 of the first heat-dissipating element 2 passed through the holes 14 of the PC board 12 to the backside of PC board 12 to first heat dissipating element 2. According to the view of the mechanical design, the at least two conductive pillars 6 does not contact with the hole-wall of the

holes 14, because there is a tolerance between the at least two conductive pillars 6 and the hole-wall of the hole 14. Nevertheless, the objective of the present invention is to improve the heat dissipation, thus, after the grounded plane 12A is passed through by the conductive pillars 6, the conductive material 42 is filled with the gap space between the hole-wall of holes 14 and the at least two conductive pillars 6.

Therefore, the heat can be removed from the grounded plane 12A of the PC board 12 to the at lest two conductive pillars 6, and is transferred to the first dissipating element 2. On the other hand, the heat can be removed from the BGA package to the heat slug 22 of the BGA to the second part of the heat sink assembly 1B to the at least two conductive pillars 6, and to the grounded plane 12A of the PC board 12. Moreover, the heat sink assembly also can be used only with at lest two conductive pillars 6, and at least two springs, but without the bottom plate 1B.

The key feature of the embodiment, the bottom plate 1B is made of the conductive material or metal, such that the bottom plate 1B can increase the heat dissipation for overall heat sink device. Furthermore, the second part of heat sink assembly 1B further comprises at least two springs 40 that put around the at least two conductive pillars 6 to pull tight between the first part of the heat sink

assembly 1A and the second part of heat sink assembly 1B.

FIG. 8 represents the cross-sectional of the construction of the ball grid array package with heat sink device 1. The heat would be generated from the chip or die during the computer is operated, thus the heat should be removed to reduce the operating temperature to keep the computer operating stability. The heat can be removed by path 1. The path 1 is that the heat is removed by introducing the heat to the heat slug 22 of BGA package to the conductive protruding block 8, first heat-dissipating element 2, and second heat-dissipating element 4. On the other hand, the path 2 is that the heat also can be removed from the backside of the PC board 12 that passed through up to the conductive pillars 6 to the first part of the heat sink assemblies 1A, or passed through down to the spring 40 to the at least two opening 32 of the sides of the bottom plate 1B to the PC board grounded layer 12A, or the heat also can be removed from the backside of the PC board 12 to the protruding part 32 of the bottom plate 1B to the PC board grounded layer 12A.

Although specific embodiments have been illustrated and described, it will be obvious to those skilled in the art that various modifications may be made without departing from what is intended to be limited solely by the appended claims.